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Mary Forcier
(TYPED OR PRINTED NAME)

Mary Forcier
(SIGNATURE OF PERSON)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Application of: Richard D. Breault	) Examiner: Tracey Mae Dove
For: Fuel Cell Temperature Control by Evaporative Cooling	) Group Art Unit: 1745
Serial No.: 10/649,244	) Docket No: C-2821
Filed on: August 27, 2003	)

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Arlington, VA 22313-1450

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES
BRIEF ON APPEAL

Sir:

Applicants present the Brief on Appeal to the Patent Office Board of Patent Appeals and Interferences pursuant to the Notice of Appeal filed on July 5, 2007.

The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 501307.

Respectfully submitted,

By [signature]
Andrew D. Gathy
Reg. No: 46,441
(860) 727-2153

Dated: September 5, 2007

UTC Power Corporation
195 Governor's Highway
South Windsor, CT 06074

Application 10/649,244 Docket No.: C-2821

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art Unit: 1745 Examiner: Tracy Mae Dove

Serial No. 10/649,244 Filed: August 27, 2003

In re Application of: Richard D. Breault

For: FUEL CELL TEMPERATURE CONTROL BY EVAPORATIVE COOLING

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

BRIEF ON APPEAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is an Appeal from the Final Office Action rejection of claims 12-21 of the above identified application mailed on April 9, 2007.

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1. REAL PARTY IN INTEREST

The real party in interest is UTC Fuel Cells, LLC, Appellant and assignee of the subject invention, now known as UTC Power Corporation a subsidiary of United Technologies Corporation.

2. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences associated with the subject application.

3. STATUS OF CLAIMS

Claims 12-21 are rejected in the application. Claims 1-11 have been withdrawn from consideration pursuant to 37 CFR 1.142(b) as being drawn to a non-elected invention. The claims under appeal are Claims 12-21 as set forth in the Claims Appendix.

4. STATUS OF AMENDMENTS

Claims 12-21 were either original or previously presented before the current Final Rejection mailed April 9, 2007. The status of the claims is also indicated in the Appendix.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention provides for a new and unexpected technique for an evaporatively cooled fuel cell. Appellant has recognized that because of the particular structure of the fuel cell, evaporative cooling can be obtained by controlling the pressure in the steam channel in response to the operating temperature while recirculating a portion of the coolant for use again as a coolant by condensing the steam outside the fuel cell. As described in Appellant's specification, and shown in the figure, the novel method controls the temperature of a fuel cell using evaporative cooling. The temperature of the fuel cell is controlled by controlling the pressure of the vapor within the steam channels. A vacuum pump can be used to draw a vacuum to reduce the steam pressure within the steam channels so that the rate of evaporation can be controlled, thus adjusting the cell temperature by controlling the vacuum pump. The steam that is evaporated from the cell stack can be condensed in an external condenser such that a portion of the condensed steam can be recirculated back to the cell stack for use as coolant to be evaporated again. Additionally, the evaporative cooling can be controlled by controlling the speed of a cooling fan for the external condenser.

The two independent claims under appeal are as follows:

12. In a stack of fuel cells (Figure, numeral 12), wherein adjacent cells (Figure, numeral 14) are separated by a porous, hydrophobic barrier layer (Figure, numeral 16) having a water intrusion pressure that prevents liquid water from crossing between cells through the barrier layer under normal operating conditions (Page 3, lines 4-15), the cell on one side of the barrier layer defining a flow channel (Figure, numeral 26) for liquid water adjacent that one side of the barrier layer, the cell on the other side of the barrier layer defining a flow channel (Figure, numeral 34) for steam adjacent that other side of the barrier layer, said water and steam flow channels being in vapor communication

with each other through the barrier layer, the process of cooling the fuel cells by evaporative cooling during fuel cell operation comprising the steps of:

flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell (Page 5, lines 13-34);

causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel (Page 7, lines 15-27), wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature (Page 2, 17-19); and

condensing the steam outside the fuel cell (Figure, numeral 44, page 6, lines 1-2) and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel.

16. (Original) A method for evaporatively cooling a plurality of adjacent fuel cells (Figure, numeral 12), wherein each cell comprises an electrolyte layer (Figure, numeral 18) sandwiched between a porous anode water transport plate (Figure, numeral 20) and a porous cathode water transport plate (Figure, numeral 22), the anode plate of one cell extending from the electrolyte layer of the cell to one side of a porous hydrophobic,

electrically conductive barrier layer (Figure, numeral 16) separating the two adjacent cells, and the cathode plate of the adjacent cell extending from the electrolyte layer of said adjacent cell to the other side of said barrier layer, the steps of:

a) flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer (Page 5, lines 13-34);

b) drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels (Page 7, lines 15-27);

c) removing the steam from the second channels (Page 5, 30-34); and,

d) controlling the amount of evaporative cooling by controlling the steam pressure in the second channels (Page 2, lines 4-35).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds are:

1. Claims 12-21 have been rejected under 35 U.S.C. § 103(a), as being unpatentable over Stedman et al. (U.S. Patent No. 3,704,172).

7. ARGUMENTS

Ground 1

<u>Arguments against the rejection of Claims 12-21 rejected under 35 U.S.C. 103(a) as being unpatentable over Stedman et al. (U.S. Patent No. 3,704,172).</u>

<u>35 U.S.C. 103(a)</u>

<u>EACH AND EVERY CLAIMED ELEMENT</u>

To establish *prima facie* obviousness of a claimed invention, all claim limitations must be taught by the prior art. *In re Royka*, 180 USPQ 580 (CCPA 1974). All words in a claim must be considered in judging the patentability of that claim against the prior art. *In re Wilson*, 165 USPQ 494 (CCPA 1970).

<u>The Stedman et al. Reference</u>

The Stedman et al. reference merely discloses a dual mode power system in which open-cycle operation is employed for short duration peak power periods and a closed cycle mode is employed for long duration base power periods (Stedman et al. at col. 1, lines 21-27). The Stedman et al. reference discloses that in the open cycle mode, the evaporated diluent (steam) is vented overboard and never to be recirculated in the cell stack. In the Stedman et al. reference heat is removed by the evaporation of the diluent and vented to atmosphere (Stedman et al. at col. 1, lines 60-68). The Stedman et al. reference explicitly states that the system can reject heat **either** by vapor venting or by radiator means (Stedman et al. at col. 2, lines 1-3). The Stedman et al. reference discloses an evaporative cooling means 30 having a liquid inlet 32 and a vapor outlet 34 for open cycle mode operation cooling (Stedman et al. at col. 2, lines 70-72). A pressure relief means 36 is disposed in the vapor outlet 34 (Stedman et al. at col. 3, lines 1-2). The Stedman et al. reference is silent with respect to condensing the steam

that flows out of the fuel cell and recirculating the condensate to be re-evaporated. The Stedman et al. reference is silent with respect to drawing a vacuum in the steam channel. The Stedman et al. reference is silent with respect to passing the steam through a radiator after the steam leaves the fuel cell. The Stedman et al. reference is silent with respect to the steam being condensed to liquid water within a radiator. The Stedman et al. reference is silent with respect to a PEM electrolyte layer. The Stedman et al. reference is silent with respect to operating reactant gases at substantially atmospheric pressure.

The Stedman et al. reference does not disclose flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell; causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel, as is claimed in part in Claim 12. The Stedman et al. reference fails to disclose that the step of reducing the pressure in the steam channel includes drawing a vacuum in the steam channel, and the step of increasing or decreasing the pressure in the steam channel includes passing the steam through a radiator after it leaves the cell and controlling the amount of heat removed from the steam within the radiator, as claimed in part in claim 13. The Stedman et al. reference fails to disclose that steam is condensed to water within the radiator and at least a portion of the condensate is made available for recirculation through said water channels, as claimed in part in claim 14. The Stedman et al.

reference fails to disclose flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer; drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels, as claimed in part in claim 16. The Stedman et al. reference fails to disclose that controlling the amount of evaporative cooling includes passing the steam from the second channels through a radiator that includes a fan, and controlling the speed of the fan to control the steam pressure in the second channels, as claimed in part in claim 18. The Stedman et al. reference fails to disclose that the operating temperature of the cell is continuously determined and the amount of evaporative cooling is regulated by adjusting the steam pressure within the steam channels in response to the operating temperature to maintain or change the operating temperature as desired, as claimed in part in claim 19. The Stedman et al. reference fails to disclose that the step of passing the steam through a radiator includes condensing steam to liquid water, wherein some of that condensed liquid water is directed into a water accumulator and recirculated through the first channels as needed as claimed in part in claim 21.

The Office Action admits that Stedman does not explicitly teach that steam that has passed through the barrier layer and through outlet 34 is condensed and returned to the reservoir. The Office Action includes the assertion that Stedman discloses that the steam that is condensed has not passed through the barrier layer (of the open cycle) but is steam exiting the fuel cell at outlet 28 (of the closed cooling cycle). The Office Action erroneously draws the conclusion that since the Stedman reference teaches a closed cooling system that includes condensing the steam in a radiator, then one of ordinary skill would have modified the open cycle cooling loop such that the steam

formed in the open cycle cooling loop that exits outlet 34 would be coupled to a radiator/condenser to recycle the steam similar to the closed cooling loop.

The Stedman et al. reference explicitly discloses a fuel cell with two modes of cooling, the open cycle mode and the closed cycle mode. In the Stedman et al. reference open cycle cooling mode is independent of and separate from the closed cycle mode of cooling with respect to the fuel cell downstream of the evaporative cooling means 30 out through the vapor outlet 34 and exiting out the pressure relief means 36 to atmosphere. An "open cycle" is inherently distinct from a "closed cycle." The Stedman et al. reference is explicit and clear at distinguishing the two cooling cycle modes in the figure and specification at the bottom of column 2 and top of column 3.

Stedman et al. explicitly discloses that the waste heat is rejected either by vapor venting (latent heat evaporative cooling) or by radiator means (sensible heat liquid cooling). Stedman et al. provides a closed cycle cooling mode that does not allow for the steam to pass through the evaporative cooling means 30 out through the vapor outlet 34. The closed cycle cooling mode recirculates the liquid coolant, but does not employ evaporative cooling means 30. The Stedman et al. reference explicitly discloses that in the alternative mode of cooling, i.e., the open cycle mode, the cooling fluid (diluent) is heated and evaporated such that the steam crosses through the evaporative cooling means 30 and flows out of the vapor outlet 34 and flows out the pressure relief means 36 exiting to atmosphere. The steam that is used in the open cycle mode is not piped to a condenser to be condensed and is not returned back to an accumulator for recirculation as a coolant. The evaporative cooling cycle (diluent) vapor of Stedman et al. is discharged overboard, never recirculated. The Stedman et al. reference is silent with respect to drawing a vacuum.

The Stedman et al. reference explicitly teaches the advantage of having two distinct cooling modes, an open cycle mode that vents overboard and a closed cycle mode that

cools through a radiator. The capability of the Stedman et al. system to reject waste heat either by vapor venting or by radiator means is particularly advantageous for space shuttle vehicles, where heat rejection by radiator is impossible during reentry, or for satellites which require periodic high power but are limited in their allowable radiator areas (Steadman et al. at col. 2, lines 1-16). The Stedman et al. reference emphasizes the reduction and if possible the elimination of radiators/condensers.

Therefore, the Steadman teaches the principal of operating in two distinct cooling modes; (1) an open cycle cooling mode, (2) a closed cycle cooling mode. Steadman et al. explicitly teaches that the closed cycle cooling mode, which employs a radiator, is impossible to operate under certain conditions, (i.e. reentry of space shuttle). The open cycle cooling mode is employed during such conditions. Stedman et al. explicitly teaches that radiator area is limited. Steadman et al. explicitly teaches that the open cycle cooling mode eliminates the need to size the closed cycle components, (e.g., radiators/condensers) for peak power conditions.

In complete contrast to Stedman et al., the claimed invention causes the liquid water to boil as it flows through the water channel, at least some of the (water) steam passes through the barrier layer into the steam channel and is condensed outside the fuel cell and a portion of the condensed steam is recirculated back to the flowing liquid water, wherein the steam originated as the flowing liquid water is converted into steam and passed through the barrier layer into the steam channel. The claimed invention also includes drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels.

Since the Stedman et al. reference fails to disclose each and every claimed element as claimed in claims 12-21, then there is no *prima facie* case of obviousness.

MOTIVATION OR SUGGESTION TO MODIFY REFERENCE

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

The Office Action suggests modifying the Stedman et al. reference to include an additional radiator/condenser (i.e., having two closed cycle cooling loops by eliminating the open cycle cooling loop) in order for condensing/recycling the steam from outlet 34. The proposed modification is completely opposed to discharging the steam overboard to atmosphere in an open cycle cooling mode as taught in the Stedman et al reference. To condense/recycle the steam from outlet 34 radically changes the open cycle cooling mode of Stedman et al. to a closed cycle cooling mode. The Stedman et al. reference explicitly teaches a dual mode fuel cell having an independent closed cycle cooling mode and an independent open cycle cooling mode to be used independently. The Stedman et al. reference clearly teaches the need to have both an open cycle cooling mode and a closed cycle cooling mode depending on the needs of the power plant during a mission. The principle of operation of an open cycle cooling mode includes discharging the steam overboard never to be returned in the cooling loop. There is no recycle of steam condensate in an open cycle cooling loop. Stedman et al. is clear regarding the independent use of and the advantages of the open cycle cooling mode and the closed cycle cooling mode. During a reentry from outer space, the closed cooling mode cannot operate. The fuel cell would have no cooling means during that operation. Converting the open cycle cooling mode to a closed cycle mode, as suggested in the Office Action, would leave the fuel cell with no means of cooling during reentry conditions. The idea of eliminating the open cycle cooling mode by adding a radiator and condenser to recycle the coolant is completely in opposition to the principle

of operation taught in the Stedman et al. reference. The modification loses the advantage of having an open cycle cooling mode, for example, when a closed cooling mode is impossible to operate upon reentry from orbit. The modification of adding another radiator creates greater weight and takes up additional space within the power plant, thus creating another problem for the fuel cell, of which Stedman et al. remedies by having the open cycle cooling loop as part of a dual mode cooling fuel cell.

The Office Action has proposed modifying the open cycle cooling mode to become a closed cycle cooling mode. The Office Action modification changes the principle of operation of the Stedman et al. invention. Changing the principle of operation of the prior art in order to render the claims obvious is impermissible and a clear error. Thus the rejection set forth modifying the Stedman et al. prior art is not sufficient to render the claims *prima facie* obvious.

Additionally, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984).

The Office Action has suggested modifying the Stedman et al. device to include a radiator to condense/recycle the steam from outlet 34. The Office Action modification renders the Stedman et al. device unsatisfactory for its intended purpose. The Stedman et al. reference unequivocally teaches a dual mode cooling system. The proposed modification eliminates one of the two cooling modes. The modification places a radiator on an open cycle cooling mode system, changing the open cycle system to a closed cycle system. The steam exiting outlet 34 would no longer be evacuated to atmosphere as originally taught in Stedman et al. The steam would be sent to a radiator to be condensed/recycled. The Steadman et al. reference explicitly teaches the advantage to having <u>both</u> an open cycle cooling mode as well as a closed cycle cooling mode. Modifying the Stedman et al. reference, as the Office Action had suggested,

eliminates the advantage of the open cycle cooling mode and actually creates a system that is impossible to use under certain operating conditions, (e.g., reentry from orbit of the space shuttle). The modification of the radiator, as suggested by the Office Action, adds weight and enlarges the size of the closed cooling mode systems, thus defeating another advantage taught by Stedman et al. (i.e., minimizing the weight and component size of the open cycle system). Eliminating the closed loop cooling cycle renders the Stedman et al. power plant useless in conditions that require an open cycle cooling mode to cool the fuel cell. In certain space operations the fuel cell requires the capacity to be cooled via the open cycle. The modification suggested by the Office Action renders the fuel cell useless, radiators cannot be used to cool the fuel cell on reentry from space.

Since the proposed modification suggested in the Office Action renders the Stedman et al. dual mode cooling systems unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. If there is no suggestion or motivation to modify the prior art reference, then there is no *prima face* case of obviousness.

Finally, Appellant is including objective evidence in the form of a Declaration from one skilled in the art, Gregory Reynolds. The Declaration is part of the prosecution file submitted on January 30, 2007 in response Examiner's earlier rejection and considered by the Examiner in the Final Office Action mailed April 9, 2007 at page 4, Response to Arguments. The Declaration unequivocally refutes the opinions of the Examiner with respect to the Stedman et al. reference and is pertinent evidence for this appeal. The Declaration makes it very clear that the Stedman et al. reference deploys a specific dual mode power system with an open-cycle operation and an independent closed cycle mode. The evidence and facts on the record make it very clear that the Stedman et al. reference cannot be modified to render the claimed invention obvious. The Examiner has merely provided unsupported conclusory statements of opinion and placed no

objective evidence into the record of the case to refute the Declaration evidence and evidence on the record provided by Appellant. Rejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support legal conclusions of obviousness. Indeed the Declaration evidence of an individual with over 35 years of fuel cell experience provides the foundation that the common sense of those skilled in the art demonstrates why the claimed invention <u>would not have been obvious</u> in view of the Stedman et al. reference. The evidence on the record refutes the assertion that one of ordinary skill would modify the Stedman et al. reference to read on the claimed invention.

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CONCLUSION

Accordingly, Appellant's claims are not rendered obvious by the prior art of record.

The Stedman et al. reference fails to teach or suggest all of the elements of independent Claims 12 and 16. Additionally, the proposed modifications in the Office Action would change the principle of operation of the Stedman et al. reference, and therefore, the claims are not *prima facie* obvious. Moreover, the proposed modifications in the Office Action renders the Stedman et al. dual mode cooling systems unsatisfactory for its intended purpose, and therefore, the claims are not *prima facie* obvious. Therefore, there is no *prima facie* case of obviousness.

In view of the above, Appellant respectfully submits that the claimed invention is not obvious to one skilled in the art in view of the Stedman et al. reference.

The Appellant respectfully requests that the rejection of the Examiner be reversed and the appealed claims be allowed to issue.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1307.

Respectfully submitted,

Andrew D. Gathy
Reg. No: 46,441
(860) 727-2153

Dated:September 5, 2007

8. CLAIMS APPENDIX

Listing of Claims:

1. (Withdrawn) A fuel cell system including a cell stack comprising a plurality of adjacent fuel cells, each cell comprising a) anode plate means, b) cathode plate means, and c) an electrolyte layer sandwiched between said anode and cathode plate means;
said stack also including a hydrophobic barrier layer having a first side and second side and being sandwiched between and in contact with said anode plate means of one of said fuel cells and said cathode plate means of another of said fuel cells, said barrier layer being porous to water vapor while having a water intrusion pressure sufficiently high to prevent liquid water from passing therethrough under expected fuel cell system operating conditions;
wherein one of either said anode or cathode plate means defines, with said first side of said barrier layer, channels for carrying liquid water adjacent said first side of said barrier layer and out of said fuel cell;
and, wherein the other one of said anode or cathode plate means defines, with said second side of said barrier layer, channels for receiving steam from said liquid water channels and for carrying that steam out of said fuel cells;
said fuel cell system also including a) means connected to said liquid water channels for feeding a stream of liquid water into said liquid water channels during fuel cell operation; b)means for sensing the temperature at which the fuel cells are operating;
c)temperature control means including means i)for reducing the pressure within said steam channels to below the vapor pressure of water within said water channels to boil the water to produce steam and evaporatively cool the cells, and ii)for adjusting said steam channel pressure in response to said temperature sensing means to control the amount of evaporative cooling and maintain a desired fuel cell operating temperature range.

2. (Withdrawn) The fuel cell system according to claim 1, wherein said water channels are defined between said anode plate means and said barrier layer and said steam channels are defined between said cathode plate means and said barrier layer.

3. (Withdrawn) The fuel cell according to claim 1, wherein said electrolyte layer is a PEM.

4. (Withdrawn) The fuel cell system according to claim 3, wherein said means (i) for reducing pressure includes a vacuum pump in communication with said steam channels and said means (ii) for adjusting said steam channel pressure is a radiator for removing heat from the steam after it leaves said steam channels.

5. (Withdrawn) The fuel cell system according to claim 3, wherein said anode plate is a porous, hydrophilic water transport plate and said cathode plate is a porous, hydrophilic water transport plate.

6. (Withdrawn) The fuel cell system according to claim 4, wherein said anode plate is a porous, hydrophilic water transport plate and said cathode plate is a porous, hydrophilic water transport plate.

7. (Withdrawn) The fuel cell system according to claim 3, wherein at least one of said anode plate and cathode plate is a non-porous separator plate.

8. (Withdrawn) The fuel cell system according to claim 3, wherein both said anode plate and said cathode plate are non-porous separator plates.

9. (Withdrawn) The fuel cell system according to claim 4, wherein at least one of said anode plate and cathode plate is a non-porous separator plate.

10. (Withdrawn) The fuel cell system according to claim 4, wherein both said anode plate and said cathode plate are non-porous separator plates.

11. (Withdrawn) The fuel cell system according to claim 6, including a water accumulator for receiving condensed water from said radiator, wherein said water feeding means includes water pump means for pumping water from said accumulator into and through said water channels.

12. (Previously Presented) In a stack of fuel cells, wherein adjacent cells are separated by a porous, hydrophobic barrier layer having a water intrusion pressure that prevents liquid water from crossing between cells through the barrier layer under normal operating conditions, the cell on one side of the barrier layer defining a flow channel for liquid water adjacent that one side of the barrier layer, the cell on the other side of the barrier layer defining a flow channel for steam adjacent that other side of the barrier layer, said water and steam flow channels being in vapor communication with each other through the barrier layer, the process of cooling the fuel cells by evaporative cooling during fuel cell operation comprising the steps of:

flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell;

causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and

condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the

flowing liquid water converted into steam and passed through the barrier layer into the steam channel.

13. (Original) The cooling process according to claim 12, wherein the step of reducing the pressure in the steam channel includes drawing a vacuum in the steam channel, and the step of increasing or decreasing the pressure in the steam channel includes passing the steam through a radiator after it leaves the cell and controlling the amount of heat removed from the steam within the radiator.

14. (Original) The cooling process according to claim 13, wherein steam is condensed to water within the radiator and at least a portion of the condensate is made available for recirculation through said water channels.

15. (Original) The cooling process according to claim 13, wherein each fuel cell includes a PEM and operates on reactant gasses that are at substantially atmospheric pressure, and the pressure in the steam channels is controlled to maintain the cell operating temperature between 150°F and 180°F.

16. (Original) A method for evaporatively cooling a plurality of adjacent fuel cells, wherein each cell comprises an electrolyte layer sandwiched between a porous anode water transport plate and a porous cathode water transport plate, the anode plate of one cell extending from the electrolyte layer of the cell to one side of a porous hydrophobic, electrically conductive barrier layer separating the two adjacent cells, and the cathode plate of the adjacent cell extending from the electrolyte layer of said adjacent cell to the other side of said barrier layer, the steps of:

a) flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer;

b) drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the

second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels;

c) removing the steam from the second channels; and,

d) controlling the amount of evaporative cooling by controlling the steam pressure in the second channels.

17. (Original) The method according to claim 16, wherein the electrolyte layer is a PEM.

18. (Original) The method according to claim 16, wherein the step (d) of controlling the amount of evaporative cooling includes passing the steam from the second channels through a radiator that includes a fan, and controlling the speed of the fan to control the steam pressure in the second channels.

19. (Original) The method according to claim 16, wherein in step (d) the operating temperature of the cell is continuously determined and the amount of evaporative cooling is regulated by adjusting the steam pressure within the steam channels in response to the operating temperature to maintain or change the operating temperature as desired.

20. (Original) The method according to claim 19, wherein the electrolyte layer is a PEM.

21. (Original) The method according to claim 18, wherein the step of passing the steam through a radiator includes condensing steam to liquid water, wherein some of that condensed liquid water is directed into a water accumulator and recirculated through the first channels as needed.

9. EVIDENCE APPENDIX

The Declaration of Gregory Reynolds is provided as evidence of fact submitted in the Response to Office Action filed on January 30, 2007 and considered by the Examiner in the Final Office Action mailed on mailed April 9, 2007 at page 4, Response to Arguments.

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C-2821

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art Unit: 1745 Examiner: Tracy Mae Dove

Serial No. 10/649,244 Filed: August 27, 2003

In re Application of: Richard D. Breault

For: FUEL CELL TEMPERATURE CONTROL BY EVAPORATIVE COOLING

DECLARATION OF GREGORY REYNOLDS

Commissioner for Patents
Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Greg Reynolds, hereby declare and state as follows:

1. This Declaration is being submitted by Gregory Reynolds having a residence at 127 Skyline Drive South Windsor Connecticut, 06074.

2. I hold a B.S. in Mechanical Engineering from the University of Rhode Island. I am currently employed by the assignee of the above-identified patent application. I have been an active full time participant in the field of fuel cells and fuel cell related systems for over 35 years. Practitioners regard me as an expert in the fuel cell industry regarding fuel cell stacks and fuel cell operation. Because of my education and experience, I believe myself to be a person skilled in the art in fuel cell systems and design.

3. I am familiar with the above referenced patent application including the claims.

4. I have read and understand the presently outstanding Office Action in the above-identified patent application, mailed September 6, 2006.

5. I have read and understand the cited prior art reference of Stedman et al. (US Patent No. 3,704,172).

6. The Stedman et al. reference describes a dual mode power system in which open-cycle operation is employed for short duration peak power periods and a closed cycle mode is employed for long duration base power periods (Stedman et al. at col. 1, lines 21-27).

7. The Stedman et al. reference describes that in open cycle mode heat is removed by the evaporation of the diluent and vented to atmosphere (Stedman et al. at col. 1, lines 60-68).

8. The Stedman et al. reference describes an evaporative cooling means 30 having a liquid inlet 32 and a vapor outlet 34 for open cycle mode operation cooling (Stedman et al. at col. 2, lines 70-72).

9. The Stedman et al. reference describes a pressure relief means 36 which may be a pressure relief valve, is disposed in the vapor outlet 34 (Stedman et al. at col. 3, lines 1-2).

10. The Stedman et al. reference depicts in the figure the pressure relief valve 36 downstream of the vapor outlet 34.

11. The Stedman et al. figure depicts the vapor outlet 34 in communication with the upstream liquid inlet 32 as part of the evaporative cooling means 30.

12. The Stedman et al. figure depicts an open ended pipeline downstream of the pressure relief valve 36. Thus, the steam from the evaporative cooling means 30 flowing into and through the vapor outlet 34 and then through the pressure relief means 36 is discharged directly out to atmosphere.

13. There is no other apparatus or device coupled downstream of the pressure relief valve 36, of the Stedman et al. reference.

14. The Stedman et al. reference describes a control means 70 operatively connected to first pressure sensing means 72 in the vapor outlet of the evaporative cooling means 30 (Stedman et al. at col. 3, lines 57-59).

15. The Stedman et al. reference further describes that the control

means 70 is operatively connected to second pressure sensing means 74 in the conduit 66 and is operatively connected to valve means 68 for regulating the valve means 68 to maintain a predetermined pressure differential between the vapor outlet 34 and the coolant liquid in the conduit 66. (Stedman et al. at col. 3, lines 60-64).

16. The Stedman et al. reference is silent with respect to describing drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels, as is claimed in part in claim 16.

17. It is well understood in the fuel cells art that a pressure relief valve does not create or draw a vacuum for fluids upstream of the pressure relief valve. A pressure relief valve has a higher pressure upstream of the valve and typically a lower pressure downstream of the valve.

18. Based on what is described in Stedman et al. and the lack of disclosure of Stedman et al. coupled with the basic understanding of the operation of pressure relief valves, one of ordinary skill in the art would not conclude that the Stedman et al. reference discloses drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels, as is claimed in part in claim 16.

19. The Stedman et al. reference does not disclose flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell; causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer

into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel, as is claimed in part in Claim 12.

20. The Stedman et al. reference undoubtedly depicts the steam from the evaporative cooling means 30 piped through the vapor outlet 34 to discharge to atmosphere through the pressure relief valve 36. The steam from the evaporative cooling means 30 never flows to a radiator, or a condenser or an accumulator or any other device after flowing through the vapor outlet 34 and pressure relief means 36.

21. I further declare that all statements made of my own knowledge are true and all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and may jeopardize the validity or enforceability of a patent issued from this patent application.

1/8/07 Gregory Reynolds

Date Gregory Reynolds

10. RELATED PROCEEDINGS APPENDIX

None

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PTO/SB/21 (04-07)
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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	10/649,244
Filing Date	August 27, 2003
First Named Inventor	Richard D. Breault
Art Unit	1745
Examiner Name	Tracey Mae Dove
Attorney Docket Number	C-2821

Total Number of Pages in This Submission

ENCLOSURES *(Check all that apply)*

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment/Reply
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Reply to Missing Parts/ Incomplete Application
  - ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53
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- ☐ After Allowance Communication to TC
- ☐ Appeal Communication to Board of Appeals and Interferences
- ☑ Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- ☐ Proprietary Information
- ☐ Status Letter
- ☐ Other Enclosure(s) (please Identify below):

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	UTC Power Corporation		
Signature			
Printed name	Andrew D. Gathy		
Date	September 5, 2007	Reg. No.	46,441

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Mary Forcier		
Typed or printed name	Mary Forcier	Date	September 5, 2007

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I HEREBY CERTIFY THAT THIS PAPER OR FEE IS BEING FACSIMILE TRANSMITTED TO 571-273-8300 ON September 5, 2007

Mary Forcier
(TYPED OR PRINTED NAME)

Mary Forcier
(SIGNATURE OF PERSON)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Application of: Richard D. Breault	) Examiner: Tracey Mae Dove
For: Fuel Cell Temperature Control by Evaporative Cooling	) Group Art Unit: 1745
Serial No.: 10/649,244	) Docket No: C-2821
Filed on: August 27, 2003	)

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Commissioner for Patents
P.O. Box 1450
Arlington, VA 22313-1450

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES
BRIEF ON APPEAL

Sir:

Applicants present the Brief on Appeal to the Patent Office Board of Patent Appeals and Interferences pursuant to the Notice of Appeal filed on July 5, 2007.

The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 501307.

Respectfully submitted,

By [signature]
Andrew D. Gathy
Reg. No: 46,441
(860) 727-2153

Dated: September 5, 2007

UTC Power Corporation
195 Governor's Highway
South Windsor, CT 06074

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Application **10/649,244** Docket No.: C-2821

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art Unit: 1745 Examiner: Tracy Mae Dove

Serial No. 10/649,244 Filed: August 27, 2003

In re Application of: Richard D. Breault

For: FUEL CELL TEMPERATURE CONTROL BY EVAPORATIVE COOLING

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

BRIEF ON APPEAL

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is an Appeal from the Final Office Action rejection of claims 12-21 of the above identified application mailed on April 9, 2007.

TABLE OF CONTENTS

1. REAL PARTY IN INTEREST

The real party in interest is UTC Fuel Cells, LLC, Appellant and assignee of the subject invention, now known as UTC Power Corporation a subsidiary of United Technologies Corporation.

2. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences associated with the subject application.

3. STATUS OF CLAIMS

Claims 12-21 are rejected in the application. Claims 1-11 have been withdrawn from consideration pursuant to 37 CFR 1.142(b) as being drawn to a non-elected invention. The claims under appeal are Claims 12-21 as set forth in the Claims Appendix.

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4. STATUS OF AMENDMENTS

Claims 12-21 were either original or previously presented before the current Final Rejection mailed April 9, 2007. The status of the claims is also indicated in the Appendix.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention provides for a new and unexpected technique for an evaporatively cooled fuel cell. Appellant has recognized that because of the particular structure of the fuel cell, evaporative cooling can be obtained by controlling the pressure in the steam channel in response to the operating temperature while recirculating a portion of the coolant for use again as a coolant by condensing the steam outside the fuel cell. As described in Appellant's specification, and shown in the figure, the novel method controls the temperature of a fuel cell using evaporative cooling. The temperature of the fuel cell is controlled by controlling the pressure of the vapor within the steam channels. A vacuum pump can be used to draw a vacuum to reduce the steam pressure within the steam channels so that the rate of evaporation can be controlled, thus adjusting the cell temperature by controlling the vacuum pump. The steam that is evaporated from the cell stack can be condensed in an external condenser such that a portion of the condensed steam can be recirculated back to the cell stack for use as coolant to be evaporated again. Additionally, the evaporative cooling can be controlled by controlling the speed of a cooling fan for the external condenser.

The two independent claims under appeal are as follows:

12. In a stack of fuel cells (Figure, numeral 12), wherein adjacent cells (Figure, numeral 14) are separated by a porous, hydrophobic barrier layer (Figure, numeral 16) having a water intrusion pressure that prevents liquid water from crossing between cells through the barrier layer under normal operating conditions (Page 3, lines 4-15), the cell on one side of the barrier layer defining a flow channel (Figure, numeral 26) for liquid water adjacent that one side of the barrier layer, the cell on the other side of the barrier layer defining a flow channel (Figure, numeral 34) for steam adjacent that other side of the barrier layer, said water and steam flow channels being in vapor communication

with each other through the barrier layer, the process of cooling the fuel cells by evaporative cooling during fuel cell operation comprising the steps of:

flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell (Page 5, lines 13-34);

causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel (Page 7, lines 15-27), wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature (Page 2, 17-19); and

condensing the steam outside the fuel cell (Figure, numeral 44, page 6, lines 1-2) and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel.

16. (Original) A method for evaporatively cooling a plurality of adjacent fuel cells (Figure, numeral 12), wherein each cell comprises an electrolyte layer (Figure, numeral 18) sandwiched between a porous anode water transport plate (Figure, numeral 20) and a porous cathode water transport plate (Figure, numeral 22), the anode plate of one cell extending from the electrolyte layer of the cell to one side of a porous hydrophobic,

electrically conductive barrier layer (Figure, numeral 16) separating the two adjacent cells, and the cathode plate of the adjacent cell extending from the electrolyte layer of said adjacent cell to the other side of said barrier layer, the steps of:

a) flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer (Page 5, lines 13-34);

b) drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels (Page 7, lines 15-27);

c) removing the steam from the second channels (Page 5, 30-34); and,

d) controlling the amount of evaporative cooling by controlling the steam pressure in the second channels (Page 2, lines 4-35).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The grounds are:

1. Claims 12-21 have been rejected under 35 U.S.C. § 103(a), as being unpatentable over Stedman et al. (U.S. Patent No. 3,704,172).

7. ARGUMENTS

Ground 1

Arguments against the rejection of Claims 12-21 rejected under 35 U.S.C. 103(a) as being unpatentable over Stedman et al. (U.S. Patent No. 3,704,172).

35 U.S.C. 103(a)

EACH AND EVERY CLAIMED ELEMENT

To establish *prima facie* obviousness of a claimed invention, all claim limitations must be taught by the prior art. *In re Royka*, 180 USPQ 580 (CCPA 1974). All words in a claim must be considered in judging the patentability of that claim against the prior art. *In re Wilson*, 165 USPQ 494 (CCPA 1970).

The Stedman et al. Reference

The Stedman et al. reference merely discloses a dual mode power system in which open-cycle operation is employed for short duration peak power periods and a closed cycle mode is employed for long duration base power periods (Stedman et al. at col. 1, lines 21-27). The Stedman et al. reference discloses that in the open cycle mode, the evaporated diluent (steam) is vented overboard and never to be recirculated in the cell stack. In the Stedman et al. reference heat is removed by the evaporation of the diluent and vented to atmosphere (Stedman et al. at col. 1, lines 60-68). The Stedman et al. reference explicitly states that the system can reject heat **either** by vapor venting or by radiator means (Stedman et al. at col. 2, lines 1-3). The Stedman et al. reference discloses an evaporative cooling means 30 having a liquid inlet 32 and a vapor outlet 34 for open cycle mode operation cooling (Stedman et al. at col. 2, lines 70-72). A pressure relief means 36 is disposed in the vapor outlet 34 (Stedman et al. at col. 3, lines 1-2). The Stedman et al. reference is silent with respect to condensing the steam

that flows out of the fuel cell and recirculating the condensate to be re-evaporated. The Stedman et al. reference is silent with respect to drawing a vacuum in the steam channel. The Stedman et al. reference is silent with respect to passing the steam through a radiator after the steam leaves the fuel cell. The Stedman et al. reference is silent with respect to the steam being condensed to liquid water within a radiator. The Stedman et al. reference is silent with respect to a PEM electrolyte layer. The Stedman et al. reference is silent with respect to operating reactant gases at substantially atmospheric pressure.

The Stedman et al. reference does not disclose flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell; causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel, as is claimed in part in Claim 12. The Stedman et al. reference fails to disclose that the step of reducing the pressure in the steam channel includes drawing a vacuum in the steam channel, and the step of increasing or decreasing the pressure in the steam channel includes passing the steam through a radiator after it leaves the cell and controlling the amount of heat removed from the steam within the radiator, as claimed in part in claim 13. The Stedman et al. reference fails to disclose that steam is condensed to water within the radiator and at least a portion of the condensate is made available for recirculation through said water channels, as claimed in part in claim 14. The Stedman et al.

reference fails to disclose flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer; drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels, as claimed in part in claim 16. The Stedman et al. reference fails to disclose that controlling the amount of evaporative cooling includes passing the steam from the second channels through a radiator that includes a fan, and controlling the speed of the fan to control the steam pressure in the second channels, as claimed in part in claim 18. The Stedman et al. reference fails to disclose that the operating temperature of the cell is continuously determined and the amount of evaporative cooling is regulated by adjusting the steam pressure within the steam channels in response to the operating temperature to maintain or change the operating temperature as desired, as claimed in part in claim 19. The Stedman et al. reference fails to disclose that the step of passing the steam through a radiator includes condensing steam to liquid water, wherein some of that condensed liquid water is directed into a water accumulator and recirculated through the first channels as needed as claimed in part in claim 21.

The Office Action admits that Stedman does not explicitly teach that steam that has passed through the barrier layer and through outlet 34 is condensed and returned to the reservoir. The Office Action includes the assertion that Stedman discloses that the steam that is condensed has not passed through the barrier layer (of the open cycle) but is steam exiting the fuel cell at outlet 28 (of the closed cooling cycle). The Office Action erroneously draws the conclusion that since the Stedman reference teaches a closed cooling system that includes condensing the steam in a radiator, then one of ordinary skill would have modified the open cycle cooling loop such that the steam

formed in the open cycle cooling loop that exits outlet 34 would be coupled to a radiator/condenser to recycle the steam similar to the closed cooling loop.

The Stedman et al. reference explicitly discloses a fuel cell with two modes of cooling, the open cycle mode and the closed cycle mode. In the Stedman et al. reference open cycle cooling mode is independent of and separate from the closed cycle mode of cooling with respect to the fuel cell downstream of the evaporative cooling means 30 out through the vapor outlet 34 and exiting out the pressure relief means 36 to atmosphere. An "open cycle" is inherently distinct from a "closed cycle." The Stedman et al. reference is explicit and clear at distinguishing the two cooling cycle modes in the figure and specification at the bottom of column 2 and top of column 3.

Stedman et al. explicitly discloses that the waste heat is rejected either by vapor venting (latent heat evaporative cooling) or by radiator means (sensible heat liquid cooling). Stedman et al. provides a closed cycle cooling mode that does not allow for the steam to pass through the evaporative cooling means 30 out through the vapor outlet 34. The closed cycle cooling mode recirculates the liquid coolant, but does not employ evaporative cooling means 30. The Stedman et al. reference explicitly discloses that in the alternative mode of cooling, i.e., the open cycle mode, the cooling fluid (diluent) is heated and evaporated such that the steam crosses through the evaporative cooling means 30 and flows out of the vapor outlet 34 and flows out the pressure relief means 36 exiting to atmosphere. The steam that is used in the open cycle mode is not piped to a condenser to be condensed and is not returned back to an accumulator for recirculation as a coolant. The evaporative cooling cycle (diluent) vapor of Stedman et al. is discharged overboard, never recirculated. The Stedman et al. reference is silent with respect to drawing a vacuum.

The Stedman et al. reference explicitly teaches the advantage of having two distinct cooling modes, an open cycle mode that vents overboard and a closed cycle mode that

cools through a radiator. The capability of the Stedman et al. system to reject waste heat either by vapor venting or by radiator means is particularly advantageous for space shuttle vehicles, where heat rejection by radiator is impossible during reentry, or for satellites which require periodic high power but are limited in their allowable radiator areas (Steadman et al. at col. 2, lines 1-16). The Stedman et al. reference emphasizes the reduction and if possible the elimination of radiators/condensers.

Therefore, the Steadman teaches the principal of operating in two distinct cooling modes; (1) an open cycle cooling mode, (2) a closed cycle cooling mode. Steadman et al. explicitly teaches that the closed cycle cooling mode, which employs a radiator, is impossible to operate under certain conditions, (i.e. reentry of space shuttle). The open cycle cooling mode is employed during such conditions. Stedman et al. explicitly teaches that radiator area is limited. Steadman et al. explicitly teaches that the open cycle cooling mode eliminates the need to size the closed cycle components, (e.g., radiators/condensers) for peak power conditions.

In complete contrast to Stedman et al., the claimed invention causes the liquid water to boil as it flows through the water channel, at least some of the (water) steam passes through the barrier layer into the steam channel and is condensed outside the fuel cell and a portion of the condensed steam is recirculated back to the flowing liquid water, wherein the steam originated as the flowing liquid water is converted into steam and passed through the barrier layer into the steam channel. The claimed invention also includes drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels.

Since the Stedman et al. reference fails to disclose each and every claimed element as claimed in claims 12-21, then there is no *prima facie* case of obviousness.

MOTIVATION OR SUGGESTION TO MODIFY REFERENCE

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

The Office Action suggests modifying the Stedman et al. reference to include an additional radiator/condenser (i.e., having two closed cycle cooling loops by eliminating the open cycle cooling loop) in order for condensing/recycling the steam from outlet 34. The proposed modification is completely opposed to discharging the steam overboard to atmosphere in an open cycle cooling mode as taught in the Stedman et al reference. To condense/recycle the steam from outlet 34 radically changes the open cycle cooling mode of Stedman et al. to a closed cycle cooling mode. The Stedman et al. reference explicitly teaches a dual mode fuel cell having an independent closed cycle cooling mode and an independent open cycle cooling mode to be used independently. The Stedman et al. reference clearly teaches the need to have both an open cycle cooling mode and a closed cycle cooling mode depending on the needs of the power plant during a mission. The principle of operation of an open cycle cooling mode includes discharging the steam overboard never to be returned in the cooling loop. There is no recycle of steam condensate in an open cycle cooling loop. Stedman et al. is clear regarding the independent use of and the advantages of the open cycle cooling mode and the closed cycle cooling mode. During a reentry from outer space, the closed cooling mode cannot operate. The fuel cell would have no cooling means during that operation. Converting the open cycle cooling mode to a closed cycle mode, as suggested in the Office Action, would leave the fuel cell with no means of cooling during reentry conditions. The idea of eliminating the open cycle cooling mode by adding a radiator and condenser to recycle the coolant is completely in opposition to the principle

of operation taught in the Stedman et al. reference. The modification loses the advantage of having an open cycle cooling mode, for example, when a closed cooling mode is impossible to operate upon reentry from orbit. The modification of adding another radiator creates greater weight and takes up additional space within the power plant, thus creating another problem for the fuel cell, of which Stedman et al. remedies by having the open cycle cooling loop as part of a dual mode cooling fuel cell.

The Office Action has proposed modifying the open cycle cooling mode to become a closed cycle cooling mode. The Office Action modification changes the principle of operation of the Stedman et al. invention. Changing the principle of operation of the prior art in order to render the claims obvious is impermissible and a clear error. Thus the rejection set forth modifying the Stedman et al. prior art is not sufficient to render the claims *prima facie* obvious.

Additionally, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984).

The Office Action has suggested modifying the Stedman et al. device to include a radiator to condense/recycle the steam from outlet 34. The Office Action modification renders the Stedman et al. device unsatisfactory for its intended purpose. The Stedman et al. reference unequivocally teaches a dual mode cooling system. The proposed modification eliminates one of the two cooling modes. The modification places a radiator on an open cycle cooling mode system, changing the open cycle system to a closed cycle system. The steam exiting outlet 34 would no longer be evacuated to atmosphere as originally taught in Stedman et al. The steam would be sent to a radiator to be condensed/recycled. The Steadman et al. reference explicitly teaches the advantage to having <u>both</u> an open cycle cooling mode as well as a closed cycle cooling mode. Modifying the Stedman et al. reference, as the Office Action had suggested,

eliminates the advantage of the open cycle cooling mode and actually creates a system that is impossible to use under certain operating conditions, (e.g., reentry from orbit of the space shuttle). The modification of the radiator, as suggested by the Office Action, adds weight and enlarges the size of the closed cooling mode systems, thus defeating another advantage taught by Stedman et al. (i.e., minimizing the weight and component size of the open cycle system). Eliminating the closed loop cooling cycle renders the Stedman et al. power plant useless in conditions that require an open cycle cooling mode to cool the fuel cell. In certain space operations the fuel cell requires the capacity to be cooled via the open cycle. The modification suggested by the Office Action renders the fuel cell useless, radiators cannot be used to cool the fuel cell on reentry from space.

Since the proposed modification suggested in the Office Action renders the Stedman et al. dual mode cooling systems unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. If there is no suggestion or motivation to modify the prior art reference, then there is no *prima face* case of obviousness.

Finally, Appellant is including objective evidence in the form of a Declaration from one skilled in the art, Gregory Reynolds. The Declaration is part of the prosecution file submitted on January 30, 2007 in response Examiner's earlier rejection and considered by the Examiner in the Final Office Action mailed April 9, 2007 at page 4, Response to Arguments. The Declaration unequivocally refutes the opinions of the Examiner with respect to the Stedman et al. reference and is pertinent evidence for this appeal. The Declaration makes it very clear that the Stedman et al. reference deploys a specific dual mode power system with an open-cycle operation and an independent closed cycle mode. The evidence and facts on the record make it very clear that the Stedman et al. reference cannot be modified to render the claimed invention obvious. The Examiner has merely provided unsupported conclusory statements of opinion and placed no

objective evidence into the record of the case to refute the Declaration evidence and evidence on the record provided by Appellant. Rejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support legal conclusions of obviousness. Indeed the Declaration evidence of an individual with over 35 years of fuel cell experience provides the foundation that the common sense of those skilled in the art demonstrates why the claimed invention <u>would not have been obvious</u> in view of the Stedman et al. reference. The evidence on the record refutes the assertion that one of ordinary skill would modify the Stedman et al. reference to read on the claimed invention.

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CONCLUSION

Accordingly, Appellant's claims are not rendered obvious by the prior art of record.

The Stedman et al. reference fails to teach or suggest all of the elements of independent Claims 12 and 16. Additionally, the proposed modifications in the Office Action would change the principle of operation of the Stedman et al. reference, and therefore, the claims are not *prima facie* obvious. Moreover, the proposed modifications in the Office Action renders the Stedman et al. dual mode cooling systems unsatisfactory for its intended purpose, and therefore, the claims are not *prima facie* obvious. Therefore, there is no *prima facie* case of obviousness.

In view of the above, Appellant respectfully submits that the claimed invention is not obvious to one skilled in the art in view of the Stedman et al. reference.

The Appellant respectfully requests that the rejection of the Examiner be reversed and the appealed claims be allowed to issue.

The Commissioner is hereby authorized to charge any additional fees associated with this communication or credit any overpayment to Deposit Account No. 50-1307.

Respectfully submitted,

Andrew D. Gathy
Reg. No: 46,441
(860) 727-2153

Dated: September 5, 2007

8. CLAIMS APPENDIX

Listing of Claims:

1. (Withdrawn) A fuel cell system including a cell stack comprising a plurality of adjacent fuel cells, each cell comprising a) anode plate means, b) cathode plate means, and c) an electrolyte layer sandwiched between said anode and cathode plate means;
said stack also including a hydrophobic barrier layer having a first side and second side and being sandwiched between and in contact with said anode plate means of one of said fuel cells and said cathode plate means of another of said fuel cells, said barrier layer being porous to water vapor while having a water intrusion pressure sufficiently high to prevent liquid water from passing therethrough under expected fuel cell system operating conditions;
wherein one of either said anode or cathode plate means defines, with said first side of said barrier layer, channels for carrying liquid water adjacent said first side of said barrier layer and out of said fuel cell;
and, wherein the other one of said anode or cathode plate means defines, with said second side of said barrier layer, channels for receiving steam from said liquid water channels and for carrying that steam out of said fuel cells;
said fuel cell system also including a) means connected to said liquid water channels for feeding a stream of liquid water into said liquid water channels during fuel cell operation;
b)means for sensing the temperature at which the fuel cells are operating;
c)temperature control means including means i)for reducing the pressure within said steam channels to below the vapor pressure of water within said water channels to boil the water to produce steam and evaporatively cool the cells, and ii)for adjusting said steam channel pressure in response to said temperature sensing means to control the amount of evaporative cooling and maintain a desired fuel cell operating temperature range.

2. (Withdrawn) The fuel cell system according to claim 1, wherein said water channels are defined between said anode plate means and said barrier layer and said steam channels are defined between said cathode plate means and said barrier layer.

3. (Withdrawn) The fuel cell according to claim 1, wherein said electrolyte layer is a PEM.

4. (Withdrawn) The fuel cell system according to claim 3, wherein said means (i) for reducing pressure includes a vacuum pump in communication with said steam channels and said means (ii) for adjusting said steam channel pressure is a radiator for removing heat from the steam after it leaves said steam channels.

5. (Withdrawn) The fuel cell system according to claim 3, wherein said anode plate is a porous, hydrophilic water transport plate and said cathode plate is a porous, hydrophilic water transport plate.

6. (Withdrawn) The fuel cell system according to claim 4, wherein said anode plate is a porous, hydrophilic water transport plate and said cathode plate is a porous, hydrophilic water transport plate.

7. (Withdrawn) The fuel cell system according to claim 3, wherein at least one of said anode plate and cathode plate is a non-porous separator plate.

8. (Withdrawn) The fuel cell system according to claim 3, wherein both said anode plate and said cathode plate are non-porous separator plates.

9. (Withdrawn) The fuel cell system according to claim 4, wherein at least one of said anode plate and cathode plate is a non-porous separator plate.

10. (Withdrawn) The fuel cell system according to claim 4, wherein both said anode plate and said cathode plate are non-porous separator plates.

11. (Withdrawn) The fuel cell system according to claim 6, including a water accumulator for receiving condensed water from said radiator, wherein said water feeding means includes water pump means for pumping water from said accumulator into and through said water channels.

12. (Previously Presented) In a stack of fuel cells, wherein adjacent cells are separated by a porous, hydrophobic barrier layer having a water intrusion pressure that prevents liquid water from crossing between cells through the barrier layer under normal operating conditions, the cell on one side of the barrier layer defining a flow channel for liquid water adjacent that one side of the barrier layer, the cell on the other side of the barrier layer defining a flow channel for steam adjacent that other side of the barrier layer, said water and steam flow channels being in vapor communication with each other through the barrier layer, the process of cooling the fuel cells by evaporative cooling during fuel cell operation comprising the steps of:

flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell;

causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and

condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the

flowing liquid water converted into steam and passed through the barrier layer into the steam channel.

13. (Original) The cooling process according to claim 12, wherein the step of reducing the pressure in the steam channel includes drawing a vacuum in the steam channel, and the step of increasing or decreasing the pressure in the steam channel includes passing the steam through a radiator after it leaves the cell and controlling the amount of heat removed from the steam within the radiator.

14. (Original) The cooling process according to claim 13, wherein steam is condensed to water within the radiator and at least a portion of the condensate is made available for recirculation through said water channels.

15. (Original) The cooling process according to claim 13, wherein each fuel cell includes a PEM and operates on reactant gasses that are at substantially atmospheric pressure, and the pressure in the steam channels is controlled to maintain the cell operating temperature between 150°F and 180°F.

16. (Original) A method for evaporatively cooling a plurality of adjacent fuel cells, wherein each cell comprises an electrolyte layer sandwiched between a porous anode water transport plate and a porous cathode water transport plate, the anode plate of one cell extending from the electrolyte layer of the cell to one side of a porous hydrophobic, electrically conductive barrier layer separating the two adjacent cells, and the cathode plate of the adjacent cell extending from the electrolyte layer of said adjacent cell to the other side of said barrier layer, the steps of:

a) flowing liquid water adjacent one side of the barrier layer through first channels formed between one of the cell water transport plates and the barrier layer;

b) drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the

second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels;

c) removing the steam from the second channels; and,

d) controlling the amount of evaporative cooling by controlling the steam pressure in the second channels.

17. (Original) The method according to claim 16, wherein the electrolyte layer is a PEM.

18. (Original) The method according to claim 16, wherein the step (d) of controlling the amount of evaporative cooling includes passing the steam from the second channels through a radiator that includes a fan, and controlling the speed of the fan to control the steam pressure in the second channels.

19. (Original) The method according to claim 16, wherein in step (d) the operating temperature of the cell is continuously determined and the amount of evaporative cooling is regulated by adjusting the steam pressure within the steam channels in response to the operating temperature to maintain or change the operating temperature as desired.

20. (Original) The method according to claim 19, wherein the electrolyte layer is a PEM.

21. (Original) The method according to claim 18, wherein the step of passing the steam through a radiator includes condensing steam to liquid water, wherein some of that condensed liquid water is directed into a water accumulator and recirculated through the first channels as needed.

9. EVIDENCE APPENDIX

The Declaration of Gregory Reynolds is provided as evidence of fact submitted in the Response to Office Action filed on January 30, 2007 and considered by the Examiner in the Final Office Action mailed on mailed April 9, 2007 at page 4, Response to Arguments.

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C-2821

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Group Art Unit: 1745 Examiner: Tracy Mae Dove

Serial No. 10/649,244 Filed: August 27, 2003

In re Application of: Richard D. Breault

For: FUEL CELL TEMPERATURE CONTROL BY EVAPORATIVE COOLING

DECLARATION OF GREGORY REYNOLDS

Commissioner for Patents
Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Greg Reynolds, hereby declare and state as follows:

1. This Declaration is being submitted by Gregory Reynolds having a residence at 127 Skyline Drive South Windsor Connecticut, 06074.

2. I hold a B.S. in Mechanical Engineering from the University of Rhode Island. I am currently employed by the assignee of the above-identified patent application. I have been an active full time participant in the field of fuel cells and fuel cell related systems for over 35 years. Practitioners regard me as an expert in the fuel cell industry regarding fuel cell stacks and fuel cell operation. Because of my education and experience, I believe myself to be a person skilled in the art in fuel cell systems and design.

3. I am familiar with the above referenced patent application including the claims.

4. I have read and understand the presently outstanding Office Action in the above-identified patent application, mailed September 6, 2006.

5. I have read and understand the cited prior art reference of Stedman et al. (US Patent No. 3,704,172).

6. The Stedman et al. reference describes a dual mode power system in which open-cycle operation is employed for short duration peak power periods and a closed cycle mode is employed for long duration base power periods (Stedman et al. at col. 1, lines 21-27).

7. The Stedman et al. reference describes that in open cycle mode heat is removed by the evaporation of the diluent and vented to atmosphere (Stedman et al. at col. 1, lines 60-68).

8. The Stedman et al. reference describes an evaporative cooling means 30 having a liquid inlet 32 and a vapor outlet 34 for open cycle mode operation cooling (Stedman et al. at col. 2, lines 70-72).

9. The Stedman et al. reference describes a pressure relief means 36 which may be a pressure relief valve, is disposed in the vapor outlet 34 (Stedman et al. at col. 3, lines 1-2).

10. The Stedman et al. reference depicts in the figure the pressure relief valve 36 downstream of the vapor outlet 34.

11. The Stedman et al. figure depicts the vapor outlet 34 in communication with the upstream liquid inlet 32 as part of the evaporative cooling means 30.

12. The Stedman et al. figure depicts an open ended pipeline downstream of the pressure relief valve 36. Thus, the steam from the evaporative cooling means 30 flowing into and through the vapor outlet 34 and then through the pressure relief means 36 is discharged directly out to atmosphere.

13. There is no other apparatus or device coupled downstream of the pressure relief valve 36, of the Stedman et al. reference.

14. The Stedman et al. reference describes a control means 70 operatively connected to first pressure sensing means 72 in the vapor outlet of the evaporative cooling means 30 (Stedman et al. at col. 3, lines 57-59).

15. The Stedman et al. reference further describes that the control

means 70 is operatively connected to second pressure sensing means 74 in the conduit 66 and is operatively connected to valve means 68 for regulating the valve means 68 to maintain a predetermined pressure differential between the vapor outlet 34 and the coolant liquid in the conduit 66. (Stedman et al. at col. 3, lines 60-64).

16. The Stedman et al. reference is silent with respect to describing drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels, as is claimed in part in claim 16.

17. It is well understood in the fuel cells art that a pressure relief valve does not create or draw a vacuum for fluids upstream of the pressure relief valve. A pressure relief valve has a higher pressure upstream of the valve and typically a lower pressure downstream of the valve.

18. Based on what is described in Stedman et al. and the lack of disclosure of Stedman et al. coupled with the basic understanding of the operation of pressure relief valves, one of ordinary skill in the art would not conclude that the Stedman et al. reference discloses drawing a vacuum in second channels formed between the transport plate of the adjacent cell and the other side of the barrier layer to reduce the pressure in the second channels to below the vapor pressure of the water in the first channels to cause the liquid water to boil and produce steam that passes through the barrier layer into the second channels, as is claimed in part in claim 16.

19. The Stedman et al. reference does not disclose flowing liquid water into and through the water flow channel and out of the fuel cell, the water being heated within the water channel by heat produced by the fuel cell; causing the liquid water to boil as it flows through the water channel by reducing the pressure in the steam channel below the vapor pressure of the flowing liquid water to convert at least some of the water to steam that passes through the barrier layer

into the steam channel, wherein the pressure in the steam channel is increased or decreased during cell operation in response to the operating temperature of the cell to increase or decrease the operating temperature of the cell to achieve a desired cell operating temperature; and condensing the steam outside the fuel cell and recirculating a portion of the condensed steam back to the flowing liquid water, wherein the steam originated as the flowing liquid water converted into steam and passed through the barrier layer into the steam channel, as is claimed in part in Claim 12.

20. The Stedman et al. reference undoubtedly depicts the steam from the evaporative cooling means 30 piped through the vapor outlet 34 to discharge to atmosphere through the pressure relief valve 36. The steam from the evaporative cooling means 30 never flows to a radiator, or a condenser or an accumulator or any other device after flowing through the vapor outlet 34 and pressure relief means 36.

21. I further declare that all statements made of my own knowledge are true and all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and may jeopardize the validity or enforceability of a patent issued from this patent application.

1/8/07

Date

Gregory Reynolds

10. RELATED PROCEEDINGS APPENDIX

None